Supplementary Appendix

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This appendix has been provided by the authors to give readers additional information about the work.

Video versus direct laryngoscopy for tracheal intubation of critically ill adults

Supplementary Appendix

Contents

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Study concept and design: M.E.P., B.E.D., S.A.T., A.A.G., J.D.C., M.W.S.; Analysis and interpretation of data: M.E.P., B.E.D., S.A.T., B.I., L.W., D.R.J., W.H.S., T.W.R., A.A.G., J.D.C., M.W.S.; Drafting of the manuscript: M.E.P., J.D.C., M.W.S.; Critical revision of the manuscript for important intellectual content: all authors; Study supervision: M.E.P., J.D.C., M.W.S. had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. B.I. and L.W. conducted and are responsible for the data analysis.

SUPPLEMENTAL METHODS

IRB Approval and Waiver of Informed Consent

Critically ill patients undergoing tracheal intubation in the ED or ICU are at significant risk for morbidity and mortality from their underlying illness. Most patients undergoing tracheal intubation in routine clinical care are intubated using either a video laryngoscope or a direct laryngoscope on the first attempt. Any benefits or risks of these two approaches are experienced by patients undergoing tracheal intubation in clinical care, outside the context of research. As a requirement for enrollment in the DEVICE trial, the patient's treating clinician must believe that either a video laryngoscope or a direct laryngoscope would be a safe and reasonable approach for the patient (otherwise the patient is excluded). Therefore, making the decision between the two approaches randomly (by study group assignment) rather than by a clinician who thinks either approach is safe and reasonable for the patient is expected to pose no more than minimal additional risk.

Obtaining informed consent for participation in the study would be impracticable. The majority of patients undergoing emergency tracheal intubation lack decisional capacity due to their underlying critical illness and surrogate decision makers are frequently absent. Further, emergency tracheal intubation is a time-sensitive procedure with only minutes between the decision to perform intubation and the completion of the procedure. Meaningful informed consent could not be executed in this brief window and attempting to obtain informed consent would lead to potentially deleterious and unethical delays in intubation which would increase the risk of hypoxemia, hypotension, and periprocedural cardiac arrest. Because the study involves minimal incremental risk, the study would not adversely affect the welfare or privacy rights of the participant, and obtaining informed consent would be impracticable, a waiver of informed consent was requested from and approved by the single institutional review board at Vanderbilt

University Medical Center (reference number 211272). Secondary concurrence was provided by the US Department of Defense (DoD) Defense Health Agency Human Research Protection Office (EIRB# 944893).

Characteristics of Trial Intensive Care Units

Characteristic	BSW ICU	Denver Health MICU	Duke SICU	HCMC MICU	Ochsner MICU	UAB MICU	UW ICUs	Wake Forest MICU	Vanderbilt MICU	Vanderbilt Neuro ICU
Annual admissions	2,200	2,100	2,070	900	3,500	3,000	6,900	3,200	2,940	2,800
Number of beds	70	24	24	28	33	41	89	45	35	23
Annual number of tracheal intubations	200	400	170	160	400	350	1,000	350	200	200
Intubation checklist use	Never	Never	Never	Almost always	Never	Almost always	Rarely	Almost always	Never	Almost always
Personnel present at intubation										
Critical Care Attending	Always	Almost Always	Always	Almost Always	Always	Almost Always	Sometimes	Almost Always	Always	Almost Always
Critical Care Fellow	Always	Sometimes	Almost Always	Almost Always	Almost Always	Almost Always	Sometimes	Always	Always	Almost Always
Internal Medicine Resident	Sometimes	Never	Never	Never	Rarely	Sometimes	Never	Rarely	Rarely	Never
Emergency Medicine Attending	Never	Never	Never	Sometimes	Never	Never	Sometimes	Never	Never	Never
Emergency Medicine Fellow	Never	Never	Never	Rarely	Never	Never	Sometimes	Never	Never	Never
Emergency Medicine Resident	Sometimes	Never	Never	Sometimes	Never	Sometimes	Sometimes	Sometimes	Never	Never
Anesthesiology Attending	Sometimes	Almost Always	Almost Always	Never	Sometimes	Never	Almost Always	Sometimes	Never	Always
Anesthesiology Fellow	Never	Never	Almost Always	Never	Never	Rarely	Sometimes	Never	Never	Almost Always
Anesthesiology Resident	Rarely	Never	Sometimes	Never	Sometimes	Never	Almost Always	Sometimes	Never	Always
Certified Nurse Anesthetist	Never	Sometimes	Sometimes	Never	Never	Never	Almost Always	Never	Never	Never
Advanced Practice Provider	Sometimes	Almost Always	Almost Always	Never	Rarely	Rarely	Never	Sometimes	Sometimes	Never
Direct Laryngoscope Available										
Single use / Disposable	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes

DL manufacturer	Teleflex Rusch	Teleflex Rusch Polaris	Flexicare BritePro Solo	Flexicare BriteBlade Pro	Teleflex Rusch Polaris	Curaplex BriteBlade Pro 2	N/A	SunMed GreenLine/D handle and Curaplex blade	Flexicare BriteBlade Pro	Flexicare BriteBlade Pro
Video Laryngoscopes Available										
Standard Geometry Blade†										
Storz C-MAC	Yes*	No	No	Yes*	No	Yes	No	Yes*	Yes	No
McGrath MAC	No	No	Yes	No	Yes	Yes*	Yes	No	Yes*	Yes*
GlideScope MAC	No	Yes*	Yes*	Yes	No	No	Yes	No	No	No
Hyperangulated Blade†										
GlideScope LoPro	No	Yes	Yes	Yes	Yes*	No	Yes*	No	No	No
GlideScope A/GVL	No	Yes	Yes	Yes	Yes	No	No	No	Yes	No
Storz D-Blade	Yes	No	No	Yes	No	Yes	No	Yes	No	No
Bougie use on the first attempt	Sometimes	Never	Rarely	Always	Sometimes	Sometimes	Never	Rarely	Sometimes	Sometimes
Endotracheal tube manufacturer	Shiley	Shiley	Shiley	Parker	Shiley	Covidien	Shiley	Vyaire	Shiley	Shiley
Confirmation of tracheal intubation	Colorimetric $EtCO_2$ detector	Colorimetric $EtCO_2$ detector	Colorimetric $EtCO_2$ detector	Waveform capnography	Colorimetric $EtCO_2$ detector	Colorimetric $EtCO_2$ detector	Waveform capnography	Colorimetric $EtCO_2$ detector	Colorimetric $EtCO_2$ detector	Colorimetric $EtCO_2$ detector

* Video laryngoscope that is used most often by operators at that site.
† The shape of the laryngoscope blade (standard geometry vs hyperangulated) was classified as listed in the manufacturer's materials. Standard geometry blades are designed to have a curvature similar to a Macintosh direct laryngoscope blade. Hyperangulated blades are designed with a more acute angle.

ICU, intensive care unit; MICU, medical ICU; BSW, Baylor, Scott & White-Temple in Temple, TX; HCMC, Hennepin County Medical Center in Minneapolis, MN; UAB, University of Alabama at Birmingham in Birmingham, AL; UW, University of Washington Harborview Medical Center in Seattle, WA; $EtCO_2$, end-tidal carbon dioxide.

Characteristics of Trial Emergency Departments

Characteristic	BIDMC ED	Denver Health ED	HCMC ED	UAB ED	Univ Colorado ED	UW ED	Wake Forest ED
Annual ED visits	52,000	90,000	100,000	70,000	102,000	65,000	100,000
Number of beds	63	57	52	51	92	41	41
Annual number of tracheal intubations	400	500	1,200	820	300	300	600
Intubation checklist use	Rarely	Never	Always	Rarely	Never	Almost always	Rarely
Personnel present at intubation							
Critical Care Attending	Never	Never	Never	Never	Never	Never	Never
Critical Care Fellow	Never	Never	Never	Never	Never	Never	Never
Internal Medicine Resident	Never	Never	Never	Never	Never	Never	Never
Emergency Medicine Attending	Always	Always	Always	Always	Always	Always	Always
Emergency Medicine Fellow	Rarely	Rarely	Sometimes	Never	Sometimes	Sometimes	Never
Emergency Medicine Resident	Always	Always	Always	Almost Always	Always	Always	Always
Anesthesiology Attending	Rarely	Rarely	Never	Never	Never	Sometimes	Rarely
Anesthesiology Fellow	Rarely	Never	Never	Never	Never	Rarely	Never
Anesthesiology Resident	Never	Never	Never	Never	Never	Sometimes	Rarely
Certified Nurse Anesthetist	Never	Never	Never	Never	Never	Sometimes	Never
Advanced Practice Provider	Never	Never	Rarely	Never	Sometimes	Never	Sometimes
Direct Laryngoscope Available							
Single use (disposable)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DL manufacturer	Flexicare BriteBlade Pro	Teleflex Rusch Polaris	Flexicare BriteBlade Pro	Flexicare BriteBlade Pro	Teleflex Rusch TruLite	Flexicare BriteBlade Pro	Curaplex

				and Curaplex handle	Secure		
Video Laryngoscopes Available							
Standard Geometry Blade†							
Storz C-MAC	No	No	Yes*	Yes*	Yes*	No	Yes*
McGrath MAC	Yes	No	No	Yes	No	No	No
GlideScope MAC	Yes*	Yes*	Yes	No	No	Yes	No
Hyperangulated Blade†							
GlideScope LoPro	Yes	Yes	Yes	No	No	Yes*	No
GlideScope A/GVL	No	No	Yes	No	No	No	No
Storz D-Blade	No	No	Yes	Yes	Yes	No	Yes
Bougie use on the first attempt	Sometimes	Rarely	Always	Sometimes	Rarely	Rarely	Rarely
Endotracheal tube manufacturer	Vyaire	Shiley	Parker	Shiley	Shiley	Shiley	Vyaire
Confirmation of tracheal intubation	Colorimetric $EtCO_2$ detector	Colorimetric $EtCO_2$ detector	Waveform capnography	Colorimetric $EtCO_2$ detector	Waveform capnography	Waveform capnography	Colorimetric $EtCO_2$ detector

* Video laryngoscope that is used most often by operators at that site.
† The shape of the laryngoscope blade (standard geometry vs hyperangulated) was classified as listed in the manufacturer's materials. Standard geometry blades are designed to have a curvature similar to a Macintosh direct laryngoscope blade. Hyperangulated blades are designed with a more acute angle.

ED, emergency department; BIDMC, Beth Israel Deaconess Medical Center in Boston, MA; HCMC, Hennepin County Medical Center in Minneapolis, MN; UAB, University of Alabama at Birmingham in Birmingham, AL; UW, University of Washington Harborview Medical Center in Seattle, WA; $EtCO_2$, end-tidal carbon dioxide.

Inclusion and Exclusion Criteria

The inclusion criteria for the study are:

1. Patient is located in a participating unit.
2. Planned procedure is orotracheal intubation using a laryngoscope.
3. Planned operator is a clinician expected to routinely perform tracheal intubation in the participating unit.

The exclusion criteria for the study are:

1. Patient is known to be less than 18 years old.
2. Patient is known to be pregnant.
3. Patient is known to be a prisoner.
4. Immediate need for tracheal intubation precludes safe performance of study procedures.
5. Operator has determined that use of a video laryngoscope or use of a direct laryngoscope is required or contraindicated for the optimal care of the patient.

Cormack-Lehane Grade of View

To indicate the laryngeal view achieved during laryngoscopy, operators selected 1 of the 4 images shown below (corresponding to the four Cormack-Lehane grades of view[1]) on the data collection form immediately after the intubation procedure.

This image was reprinted from The Walls Manual of Emergency Airway Management, 5th Edition, Calvin A. Brown III and Ron M. Walls, Chapter 2: Identification of the Difficult and Failed Airway, Figure 2-2, Copyright (2018), with permission.

Trial Outcomes

Complete details of trial outcomes have been published in the protocol and statistical analysis plan.[2]

Primary outcome is as follows:

- Successful intubation on the first attempt. This was defined as placement of an endotracheal tube in the trachea with a single insertion of a laryngoscope blade into the mouth and either a single insertion of an endotracheal tube into the mouth or a single insertion of a bougie into the mouth followed by a single insertion of an endotracheal tube into the mouth. Data for the assessment of the primary outcome was collected by a trained independent observer using a structured data collection form that recorded the number of insertions of the laryngoscope blade, bougie (if used), and endotracheal tube into the patient's mouth. Successful intubation on the first attempt was also reported by the operator immediately following the procedure. In the event that data from the independent observer were missing, data from the operator's self-report of successful intubation on the first attempt were used. If successful intubation on the first attempt data were discordant between the independent observer and the operator, the intubation was classified as not having achieved successful intubation on the first attempt. Confirmation of endotracheal tube location in the trachea at the end of the procedure followed local protocols that included detection of end-tidal carbon dioxide.

Secondary outcome is as follows:

- Incidence of severe complications occurring between induction and 2 minutes following successful intubation. This was defined as the occurrence of one or more of the following:
    - Severe hypoxemia (lowest oxygen saturation measured by pulse oximetry < 80%);

- Severe hypotension (systolic blood pressure < 65 mm Hg or new or increased vasopressor administration);
- Cardiac arrest not resulting in death;
- Cardiac arrest resulting in death
    - Cardiac arrest will be considered to have resulted in death if a patient who experienced cardiac arrest between induction and 2 minutes after intubation died within the 1 hour following intubation.

Exploratory procedural outcomes are as follows:

- Duration of laryngoscopy and tracheal intubation. This was defined as the interval (in seconds) between the first insertion of a laryngoscope blade into the mouth and the final placement of an endotracheal tube or tracheostomy tube in the trachea.
- Number of laryngoscopy attempts
- Number of attempts to cannulate the trachea with a bougie or endotracheal tube
- Successful intubation on the first attempt without a severe complication (as defined above)
- Reason for failure to intubate the trachea on the first attempt, which include:
    - Inadequate view of the larynx
    - Inability to intubate the trachea with an endotracheal tube
    - Inability to cannulate the trachea with a bougie
    - Attempt aborted due to a change in patient condition (e.g. worsened hypoxemia, hypotension, bradycardia, vomiting, bleeding)
    - Technical failure of the laryngoscope (e.g. battery, light source, camera, screen)
    - Other
- Operator-reported aspiration – (In the trial protocol, operator-reported aspiration was classified as an exploratory procedural outcome. In the published statistical analysis plan and manuscript, however, it was classified as an exploratory safety outcome).

Exploratory safety outcomes are as follows:

- Esophageal intubation
- Injury to the teeth

Exploratory clinical outcomes are as follows:

- ICU-free days in the first 28 days
    - ICU-free days were defined as the number of days, between enrollment and 28 days after enrollment, in which the patient was alive and not admitted to an intensive care unit after the patient's final discharge from the intensive care unit. Patients who were never discharged from the intensive care unit received a value of 0. Patients who died before day 28 received a value of 0. For patients who returned to an ICU and were subsequently discharged prior to day 28, ICU-free days were counted from the date of final ICU discharge. All data were censored at hospital discharge or 28 days, whichever came first.
- Ventilator-free days in the first 28 days
    - Ventilator-free days (VFDs) were defined as the number of days, between enrollment and 28 days after enrollment, during which the patient was alive and with unassisted breathing and remained free of assisted breathing. If a patient returned to assisted breathing and subsequently achieved unassisted breathing prior to day 28, VFD were counted from the end of the last period of assisted breathing to day 28. If the patient was receiving assisted ventilation at day 28 or died prior to day 28, VFDs were 0. If a patient was discharged while receiving assisted ventilation, VFDs were 0. All data were censored at hospital discharge or 28 days, whichever came first.
- 28-day all-cause in-hospital mortality

Sample Size Calculation

The minimum clinically important difference in successful intubation on the first attempt that would be needed to justify routine use of a video laryngoscope rather than a direct laryngoscope in the ED and ICU is uncertain. The current trial was designed to detect a 5% absolute difference between groups in the incidence of successful intubation on the first attempt. An absolute difference of 5% in successful intubation on the first attempt is similar to or smaller than the difference used in the design of prior airway management trials and is considered by airway management experts to be clinically meaningful.[3–6] Assuming (1) an incidence of successful intubation on the first attempt of 80% in the direct laryngoscope group, (2) 90% statistical power, (3) a two-sided alpha of 0.05, and (4) enrollment at 16 sites with an intra-cluster correlation for the primary outcome of 0.05, we calculated that detecting a 5% absolute difference in the incidence of successful intubation on the first attempt would require enrollment of 1,920 patients (960 per group). Anticipating missing data for up to 4% of enrolled patients, we planned to enroll a total of 2,000 patients (1,000 per group).

Interim Analysis

The data and safety monitoring board (DSMB) reviewed a single interim analysis prepared by the study biostatistician at the anticipated halfway point of the trial, after enrollment of 1,000 patients. The stopping boundary for efficacy was pre-specified as a P-value of 0.001 or less, using a chi-square test, for the difference in the incidence of the primary outcome between groups. This conservative Haybittle–Peto boundary was selected to allow the final analysis to be performed using an unchanged level of significance ($P < 0.05$). The DSMB retained the authority to stop the trial at any point, request additional data or interim analyses, or request modifications of the study protocol to protect patient safety.

The 1,000th patient was enrolled in the DEVICE trial on October 1, 2022. The dataset for the interim analysis contained data on the first 1,000 patients enrolled in the trial. The single pre-specified interim analysis compared the primary outcome of successful intubation on the first attempt between patients randomized to the video laryngoscope group and patients randomized to the direct laryngoscope group using a chi-square test. Among the 1,000 patients in the dataset for the interim analysis, 425 of 494 patients (86.0%) in the video laryngoscope group had experienced the primary outcome, compared with 365 of 506 patients (72.1%) in the direct laryngoscope group ($P = 0.00000007$), which met the pre-specified stopping boundary for efficacy. After reviewing the results of the interim analysis, the DSMB recommended on November 17, 2022, that the investigators stop enrollment in the trial. The investigators immediately stopped enrollment in the trial. Between enrollment of the 1,000th patient on October 1, 2022, and stopping enrollment on November 17, 2022, an additional 420 patients were enrolled. Thus, the total number of patients enrolled in the trial was 1,420.

Date	Event Timeline
March 19, 2022	1st patient enrolled.
October 1, 2022	1,000th patient enrolled.
October 29, 2022	28-day outcomes became available for the 1,000th patient enrolled.
November 4, 2022	Dataset for interim analysis locked.
November 11, 2022	Interim analysis completed by the unblinded statistician.
November 14, 2022	DSMB members reviewed results of interim analysis.
November 17, 2022	DSMB recommended stopping enrollment in the trial because the prespecified stopping criteria for efficacy was met.
November 17, 2022	Enrollment in the trial was stopped at a final sample size of 1,420.

Sensitivity Analyses

We assessed the robustness of the findings of the primary analysis in four prespecified sensitivity analyses.

First, to account for relevant covariates and correlation within sites in a sensitivity analysis, we developed a generalized linear mixed effects model using a logit link function with the primary outcome as the dependent variable, study site as a random effect, and fixed effects of study group and the following pre-specified baseline covariates: age, sex, body-mass index, operator experience quantified as the operator's total number of prior intubations, and location of intubation (ED vs ICU). All continuous variables were modeled assuming a nonlinear relationship to the outcome using restricted cubic splines with between 3 and 5 knots.

Second, because operators could deviate from the assigned laryngoscope for the safety of the patient, we repeated the primary analysis, but considered patients for whom the operator crossed over on the first attempt from the assigned laryngoscope type to the non-assigned laryngoscope type not to have experienced successful intubation on the first attempt.

Third, we repeated the primary analysis among only patients for whom data on the primary outcome from the independent observer was available (i.e., excluding cases in which operator self-report was the sole source of information for the primary outcome).

Fourth, because the operator's prior experience with each type of laryngoscope may affect the likelihood of success with a video laryngoscope compared with a direct laryngoscope, we repeated the primary analysis among only patients for whom the operator had performed a comparable number of previous intubations using a video laryngoscope and a direct

laryngoscope, defined as having used a video laryngoscope for 25% to 75% of previous intubations.

Effect Modification

We examined whether pre-specified baseline variables modified the effect of study group assignment (video laryngoscope vs direct laryngoscope) on the primary outcome using a formal test of statistical interaction in a generalized linear mixed effects model with the primary outcome as the dependent variable, study site as a random effect, and fixed effects of study group, the pre-specified proposed effect modifier, and the interaction between the two. For categorical variables, we present the odds ratio and 95% confidence intervals within each pre-specified subgroup. Continuous variables were not dichotomized for analysis of effect modification but were dichotomized for data presentation. In accordance with the Instrument for assessing the Credibility of Effect Modification Analyses (ICEMAN) recommendations[7], we prespecified the following limited number of baseline variables as potential effect modifiers and the hypothesized direction of effect modification for each:

1. Patient location (ED vs ICU). We hypothesized that patient location would not modify the effect of study group assignment on the primary outcome.

2. Traumatic injury (Yes vs No). We hypothesized that traumatic injury would modify the effect of study group assignment on the primary outcome, with a greater increase in the incidence of successful intubation on the first attempt with use of a video laryngoscope compared with a direct laryngoscope among patients with traumatic injury compared to patients without traumatic injury.

3. Body mass index (kg/m^2). We hypothesized that body mass index would modify the effect of study group assignment on the primary outcome, with a greater increase in the incidence of successful intubation on the first attempt with use of a video laryngoscope compared with a direct laryngoscope among patients with higher body mass index as compared to patients with lower body mass index. This hypothesis of effect modification

was supported by a non-significant trend toward effect modification in a meta-analysis of multiple prior randomized trials.[8]

4. Operator's pre-enrollment assessment of the anticipated difficulty of intubation (Easy; Moderate; Difficult; Not Recorded). We hypothesized that the operator's pre-enrollment assessment would modify the effect of study group assignment on the primary outcome, with a greater increase in the incidence of successful intubation on the first attempt with use of a video laryngoscope compared with a direct laryngoscope among patients assessed as "difficult" or "moderate" compared to "easy". This hypothesis of effect modification was supported by significant effect modification in a meta-analysis of multiple prior randomized trials.[8]

5. Operator experience at the time of enrollment.

1. Total number of previous intubations performed by operator. We hypothesized that the total number of previous intubations performed by the operator would modify the effect of study group assignment on the primary outcome, with a greater increase in the incidence of successful intubation on the first attempt with use of a video laryngoscope compared with a direct laryngoscope among operators with fewer previous intubations compared to operators with a greater number of previous intubations. This hypothesis of effect modification was supported by significant effect modification observed in a prior randomized trial among critically ill adults[4], but differs from a meta-analysis including trials of intubation in the operating room that did not observe effect modification based on the operator's prior experience.[8]

2. Proportion of previous intubations performed by the operator using a video laryngoscope. We hypothesized that the proportion of previous intubations performed by the operator using a video laryngoscope would modify the effect of study group assignment on the primary outcome, with a greater increase in the

incidence of successful intubation on the first attempt with use of a video laryngoscope compared with a direct laryngoscope among operators with a higher proportion of previous intubations performed by the operator using a video laryngoscope compared to operators with a lower proportion of previous intubations performed by the operator using a video laryngoscope.

We also performed an effect modification analysis for the primary outcome that included a three-way interaction between study group, total number of previous intubations performed by the operator, and proportion of previous intubations performed by the operator using a direct laryngoscope.

Handling of Missing Data

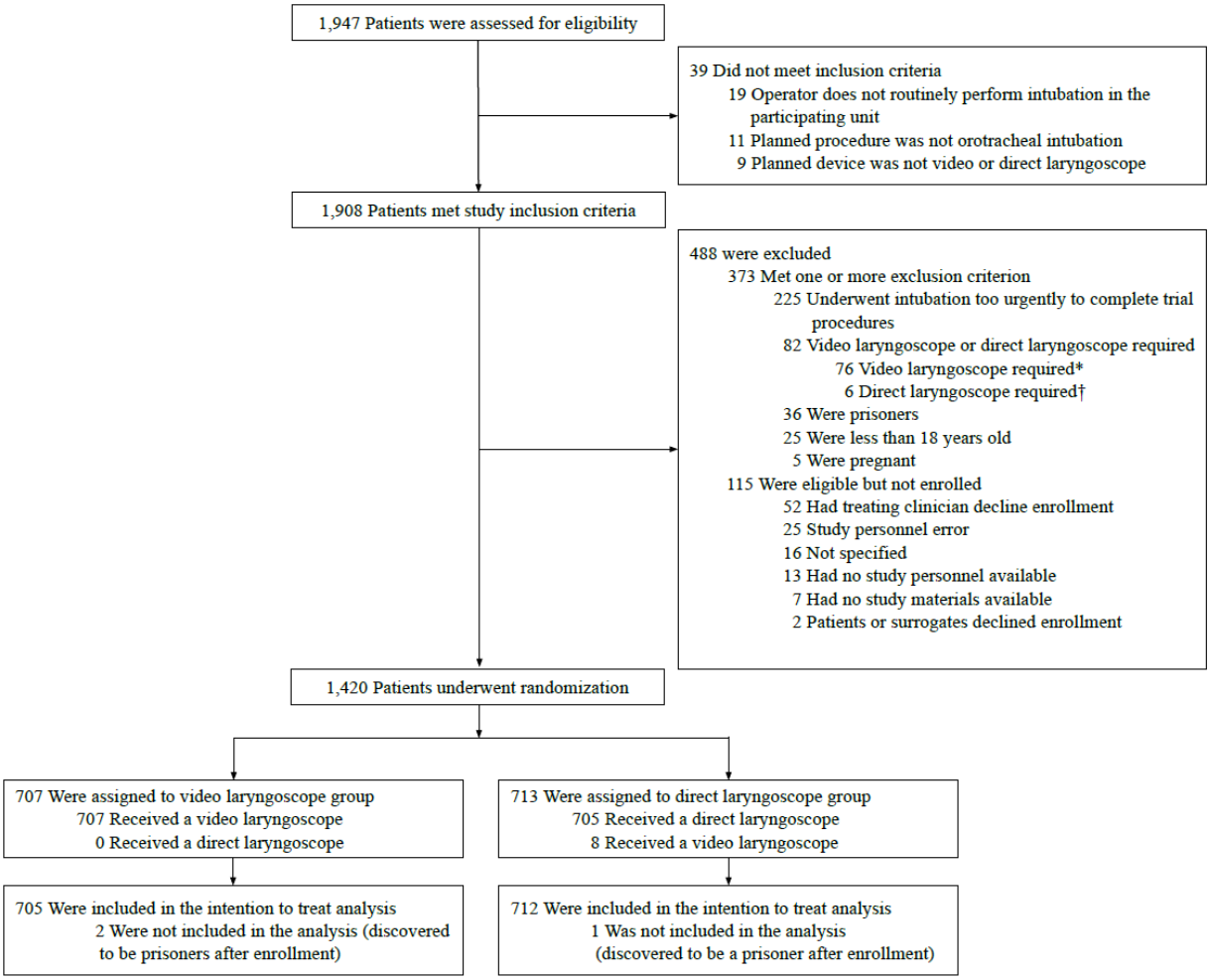
All patients had data for the primary outcome. The secondary outcome, an indicator variable for any complications occurring between induction and 2 minutes following intubation, was a composite variable comprised of multiple complications. If a patient did not have data for one of the complications used for the secondary outcome, the patient was assumed to not have experienced that specific complication. Thus, there were no cases of missing data for the secondary outcome. When data were missing for exploratory outcomes, we performed complete-case analysis, excluding cases where the data for the analyzed outcome were missing. There was no imputation of missing data for these outcomes. In adjusted analyses, missing data for covariates was imputed using multiple imputation. All variables that were included in prespecified statistical models were also included in the imputation model. This allows for the relationships held between the variables of interest to be as similar as possible with and without imputation. Variables used in the imputation model included: age, sex, body mass index, the operator's prior experience intubating with a video laryngoscope (number of intubations), study site, whether the site was an ED or ICU, and randomized treatment group assignment (direct laryngoscope or video laryngoscope). The specific method of multiple imputation used in adjusted analysis utilized bootstrapping and predictive mean matching. Samples of non-missing data were bootstrapped, then fit to an additive regression model to predict missing data. Imputation was performed using the R Statistical software's *aregImpute* function from the *Hmisc* package.[9,10]

Representativeness of the Trial Population

Category	Information
Condition under investigation	Critical illness requiring tracheal intubation in an emergency department or intensive care unit.
Special considerations related to:	
Age	The prevalence of critical illness requiring tracheal intubation increases with age.[11]
Sex and gender	Critical illness requiring tracheal intubation affects slightly more men than women.[11]
Race or ethnic group	Patients of any race or ethnicity may experience critical illness requiring tracheal intubation and invasive mechanical ventilation.[11,12]
Geography	The age, sex and gender, race and ethnic group and cause of critical illness requiring tracheal intubation varies significantly throughout the world.[12] The causes of these critical illnesses differ significantly between high-income countries and low- and middle-income countries.[13,14]
Overall representativeness of this trial	Because the DEVICE trial enrolled 72.9% of patients who underwent tracheal intubation in the study settings, the age, sex and gender, and racial/ethnic make-up of the trial population accurately reflects the characteristics of the patients cared for during clinical practice in the study settings. The trial population demonstrated the expected ratio of men to women. Race and ethnicity were reported by patients or their surrogates as part of clinical care. They were collected from the electronic health record by research personnel using fixed categories. The percentage of patients who were Black (24%) in the trial is higher than the demographics of the overall US population (www.census.gov, 2020 U.S. Census). The proportions of patients of races or ethnicities other than White or Black were lower than for the US population overall. The multicenter nature of the study contributed to geographic diversity within the United States.

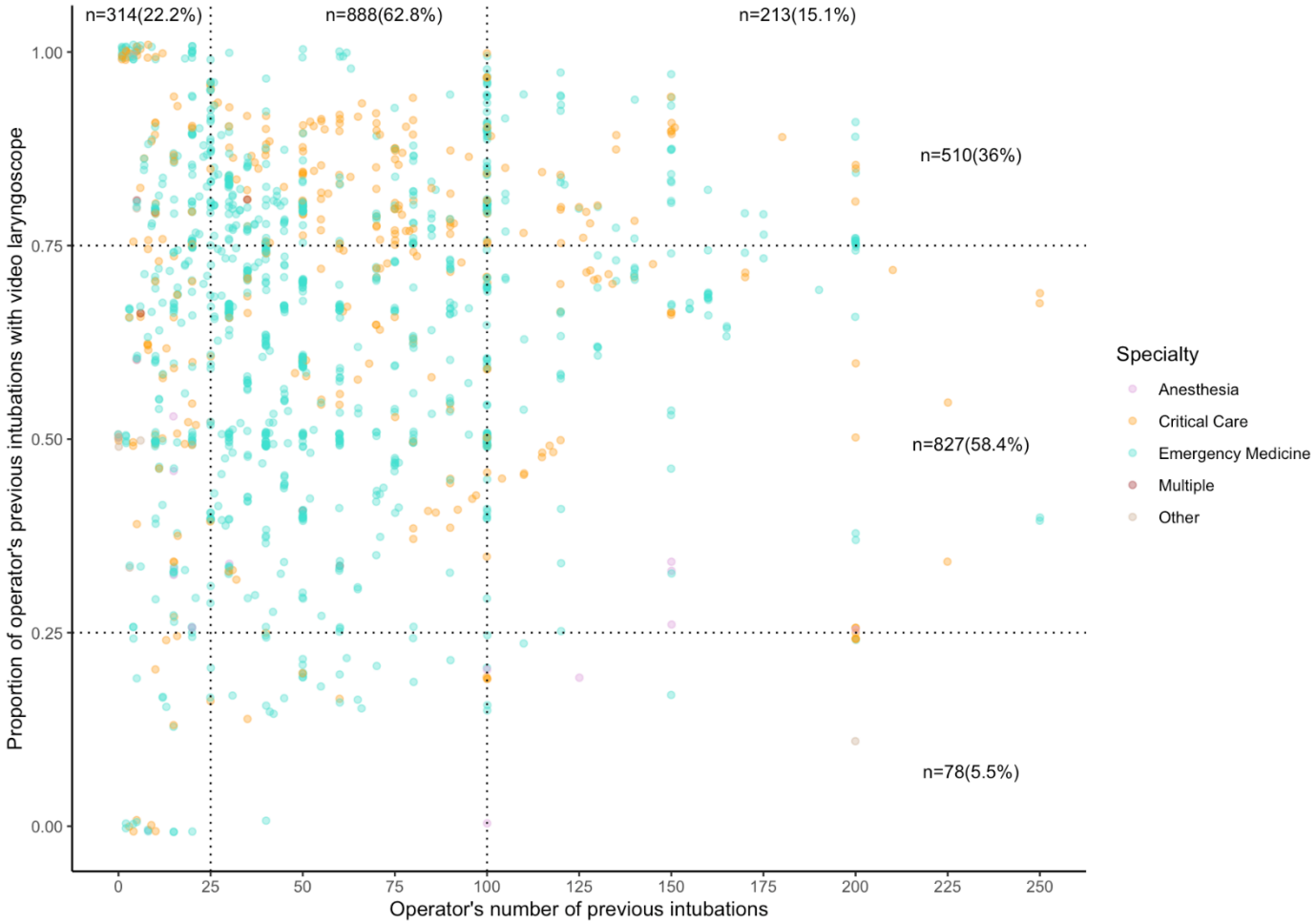
SUPPLEMENTAL FIGURES

Figure S1. Flow of participants through the trial.



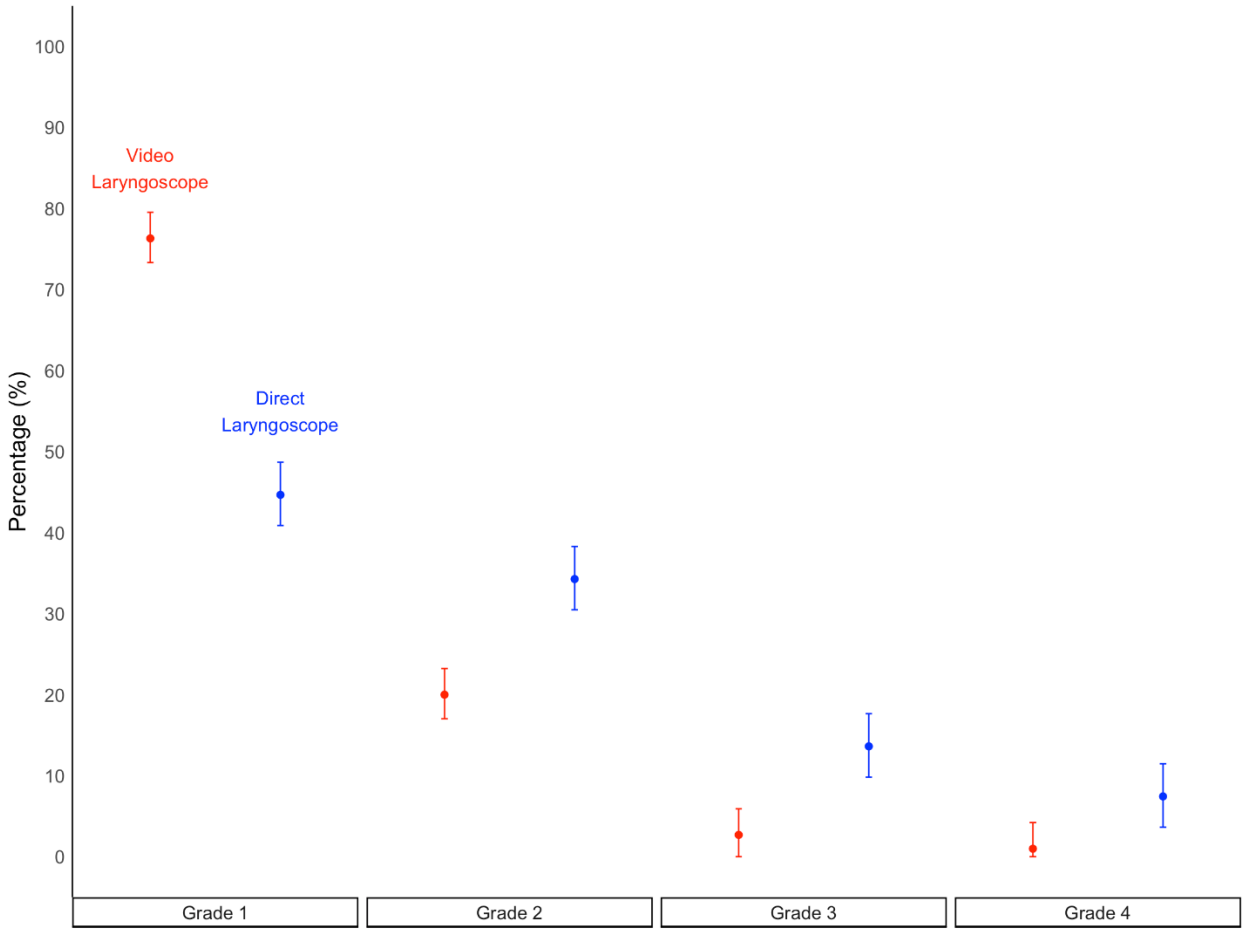
* The treating clinician determined that a video laryngoscope was required for the following reasons: extreme upper airway anatomic difficulty, 37 patients; body fluid in the upper airway, 12 patients; hyperangulated blade required, 4 patients; other reason, 23 patients.
† The treating clinician determined that a direct laryngoscope was required for the following reasons: extreme upper airway anatomic difficulty, 3 patients; body fluid in the upper airway, 2 patients; other reason, 1 patient.

Figure S2. Operator's prior number of intubations.



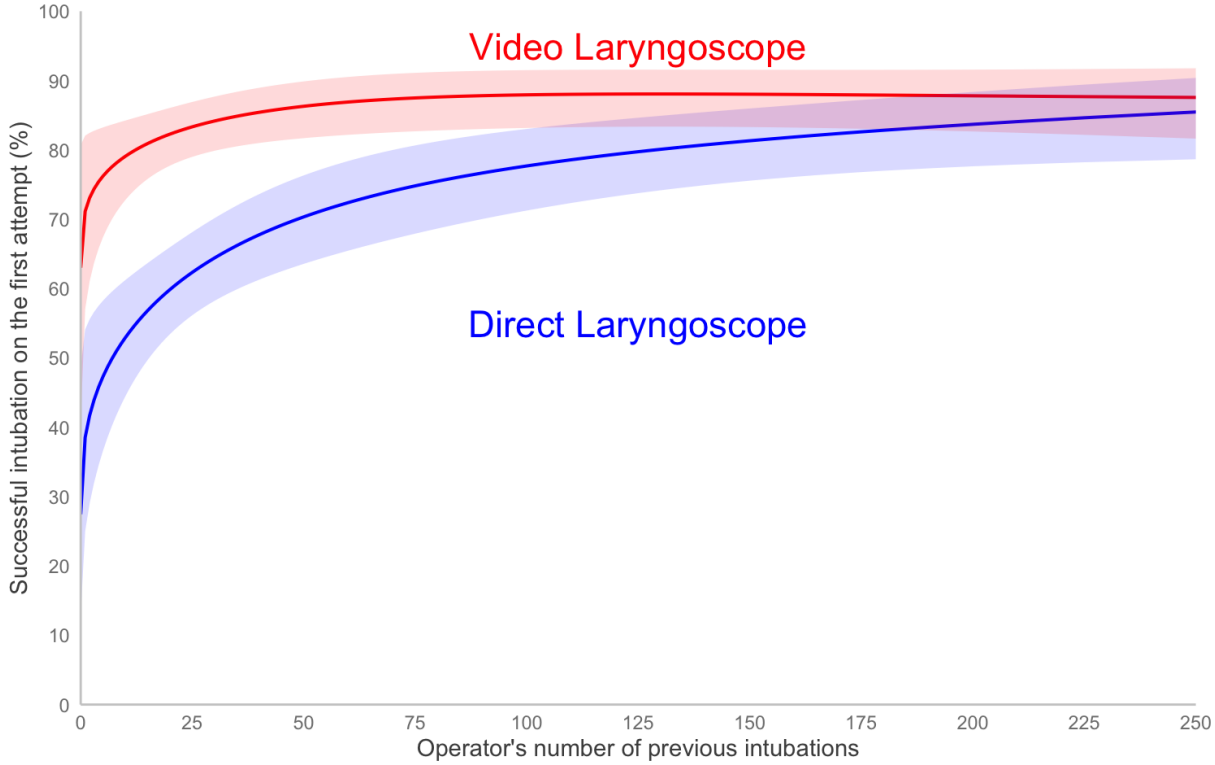
In this figure, a single point represents each of the 1415 patients in the trial for whom data were available regarding both the operator's number of previous intubations and the proportion of the operator's previous intubations that were performed with a video laryngoscope. The 39 patients for whom the operator's number of previous intubations was >250 are not displayed but are represented in listed numbers and percentages. The X-axis is the operator's total number of prior intubations at the time of enrollment of a study patient. The Y-axis is the proportion of prior intubations performed with a video laryngoscope. The proportion of the operator's prior intubations that were performed with a video laryngoscope ranged from 0.0 (all of the operator's prior intubations had been performed with a direct laryngoscope), through 0.5 (half of the operator's previous intubations had been with a video laryngoscope and half had been with a direct laryngoscope), to 1.0 (all of the operator's prior intubations had been performed with a video laryngoscope).

Figure S3. Cormack-Lehane grade of view with a video laryngoscope vs a direct laryngoscope.



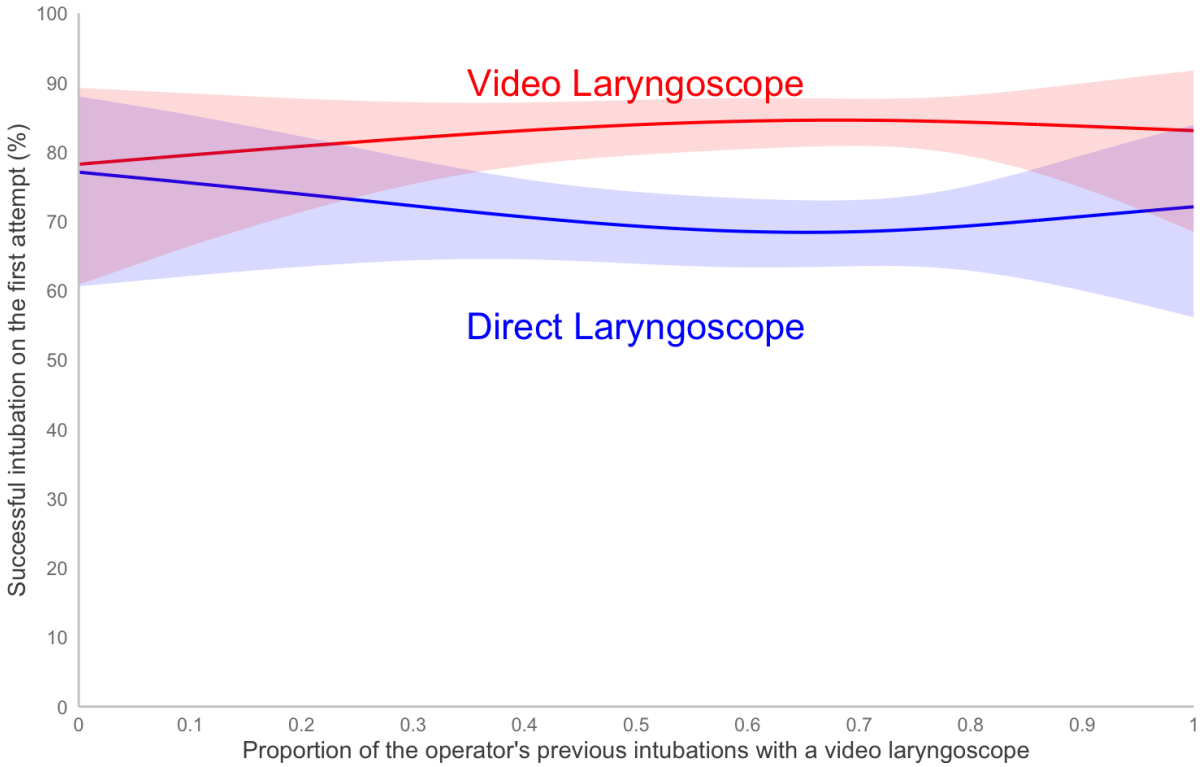
This figure displays the percentage of patients in the video laryngoscope group (red) and the direct laryngoscope group (blue) with each Cormack-Lehane grade of view. Bars indicate 95% confidence intervals. Use of a video laryngoscope appeared to increase the percentage of patients with most of the vocal cords visible (grade 1) and decrease the percentage of patients with a partial view of the vocal cords (grade 2) or no view of the vocal cords (grades 3 and 4). Inferential testing was not performed and so these findings should be interpreted as exploratory.

Figure S4. Heterogeneity of treatment effect by the operator's total number of prior intubations.



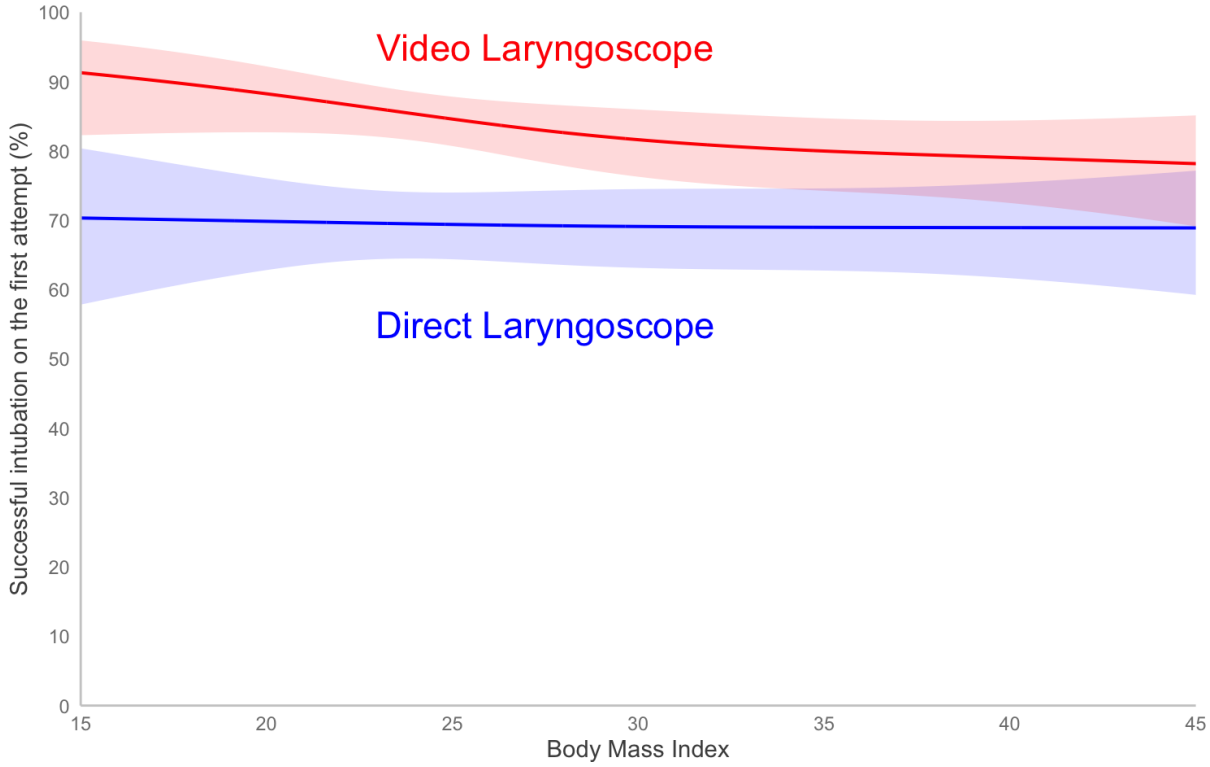
This figure displays the probability of successful intubation on the first attempt (Y-axis) in the video laryngoscope group (red) and the direct laryngoscope group (blue) by the operator's total number of prior intubations (X-axis). The operator's total number of prior intubations appeared to potentially modify the effect of use of a video laryngoscope vs a direct laryngoscope on successful intubation on the first attempt. The absolute difference in successful intubation on the first attempt between the video laryngoscope group and the direct laryngoscope group was 26.1 percentage points (15.4% to 36.8%) for the 314 cases where the operator's number of previous intubations was <25, 12.3 percentage points (6.8% to 17.7%) for the 889 cases where the operator's number of previous intubations was between 25 and 100, and 5.9 percentage points (-4.1% to 16.0%) for the 213 cases where the operator's number of previous intubations was >100. Confidence intervals were not adjusted for multiple comparisons, so they should not be used for hypothesis testing.

Figure S5. Heterogeneity of treatment effect by the proportion of the operator's prior intubations that were performed with a video laryngoscope.



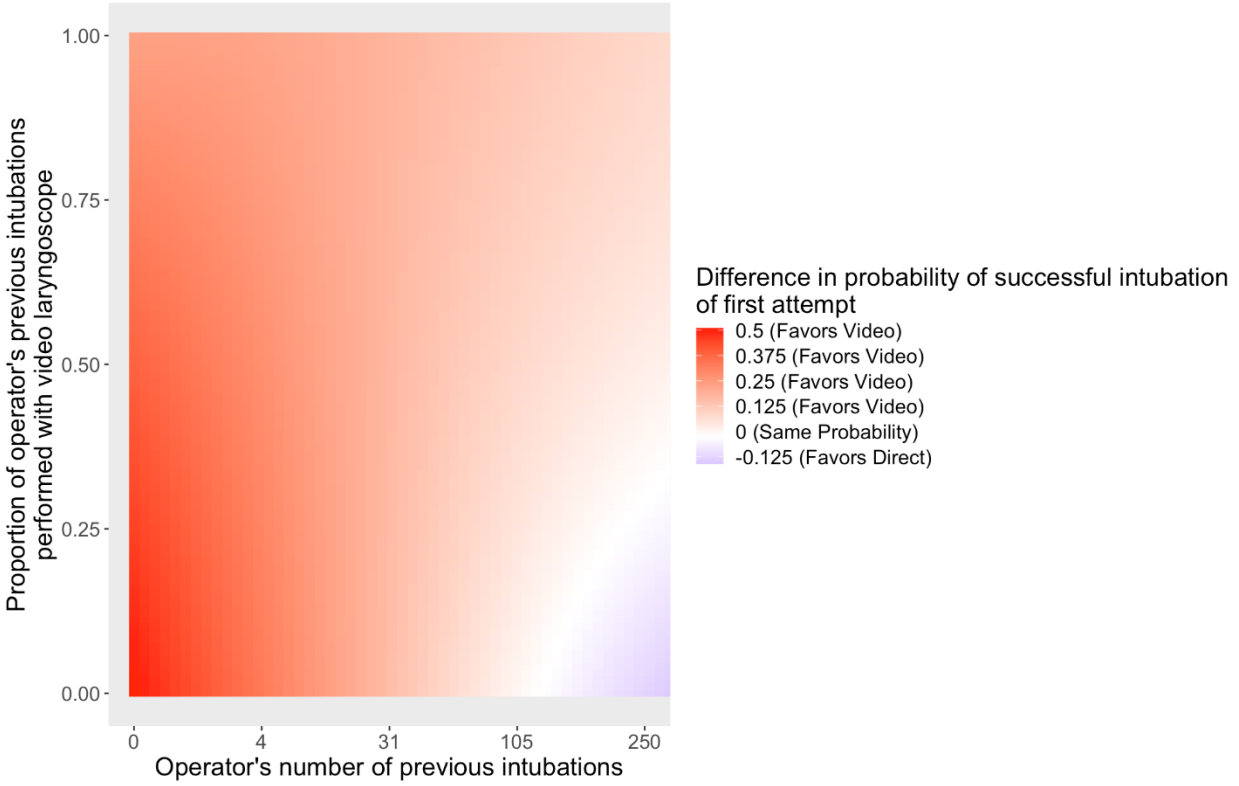
This figure displays the probability of successful intubation on the first attempt (Y-axis) in the video laryngoscope group (red) and the direct laryngoscope group (blue) by the proportion of the operator's prior intubations that were performed with a video laryngoscope. The proportion of the operator's prior intubations that were performed with a video laryngoscope ranged from 0.0 (all of the operator's prior intubations had been performed with a direct laryngoscope), through 0.5 (half of the operator's previous intubations had been with a video laryngoscope and half had been with a direct laryngoscope), to 1.0 (all of the operator's prior intubations had been performed with a video laryngoscope).

Figure S6. Heterogeneity of treatment effect by body mass index.



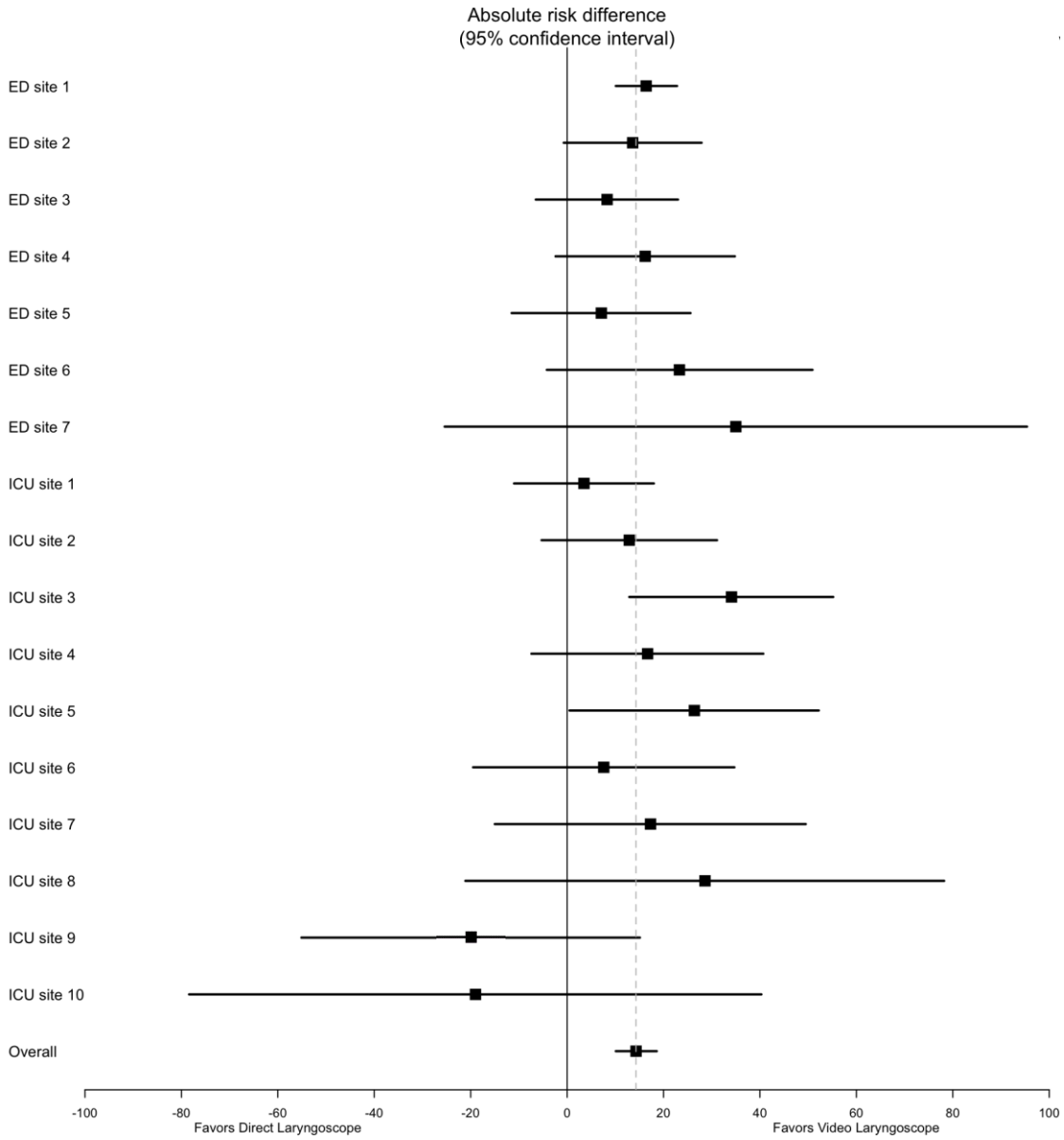
This figure displays the probability of successful intubation on the first attempt (Y-axis) in the video laryngoscope group (red) and the direct laryngoscope group (blue) by the body mass index (kg/m^2) of the patient.

Figure S7. Heterogeneity of treatment effect by the operator's total number of prior intubations and the proportion of the operator's prior intubations that were performed with a video laryngoscope.



This heat map displays the absolute risk difference in the probability of successful intubation on the first attempt between the video laryngoscope group and the direct laryngoscope group relative to the operator's total number of prior intubations (X-axis) and the proportion of the operator's prior intubations that were performed with a video laryngoscope (Y-axis). White shading indicates no difference between use of a video and a direct laryngoscope. Red shading indicates an absolute risk difference in favor of use of a video laryngoscope with darker shading indicating a greater difference. Blue shading indicates an absolute risk difference in favor of use of a direct laryngoscope with darker shading indicating a greater difference. The proportion of the operator's prior intubations that were performed with a video laryngoscope ranged from 0.0 (all of the operator's prior intubations had been performed with a direct laryngoscope), through 0.5 (half of the operator's previous intubations had been with a video laryngoscope and half had been with a direct laryngoscope), to 1.0 (all of the operator's prior intubations had been performed with a video laryngoscope).

Figure S8. Successful intubation on the first attempt by site.



Shown is the unadjusted absolute risk difference in the primary outcome of successful intubation on the first attempt between use of a video laryngoscope and use of a direct laryngoscope for patients at each of the 17 trial sites. Horizontal bars represent the 95% confidence intervals around the absolute risk difference. Confidence intervals were not adjusted for multiple comparisons, so they should not be used for hypothesis testing. The point estimate favored use of a video laryngoscope at all sites except the two sites that enrolled 10 or fewer patients. ED = Emergency Department; ICU = Intensive Care Unit.

SUPPLEMENTAL TABLES

Table S1. Characteristics of patients in the cohort for the interim analysis

Characteristic*	Video Laryngoscope (n = 494)	Direct Laryngoscope (n = 506)
Age, years – median (IQR)	52 (35-66)	55 (38-66)
Female sex – no. (%)	172 (34.8)	176 (34.8)
Body mass index, kg/m^2 – median (IQR)	26.6 (23.0-31.5)	26.4 (23.0-31.5)
APACHE II score – median (IQR)	16 (11-21)	16 (11-22)
Traumatic injury prior to intubation – no. (%)	129 (26.1)	119 (23.5)
Anticipated difficulty of intubation – no. (%)		
Easy	158 (32.0)	152 (30.0)
Moderate	223 (45.0)	239 (47.2)
Difficult	46 (9.3)	39 (7.7)
Not reported	67 (13.6)	76 (15.0)
Primary outcome – no. (%)		
Successful intubation on the first attempt	425 (86.0)	365 (72.1)

* This table presents the characteristics of the 1,000 patients who were in the cohort for the interim analysis. The characteristics of patients in the final trial population of 1,417 patients are displayed in subsequent tables.

Table S2. Race or ethnic group

Group*	Video Laryngoscope (n=705)	Direct Laryngoscope (n=712)
Patient race†		
White	411 (58.3)	391 (54.9)
Black	174 (24.7)	172 (24.2)
American Indian or Alaska Native	35 (5.0)	41 (5.8)
Asian	14 (2.0)	25 (3.5)
Native Hawaiian or Other Pacific Islander	4 (0.6)	6 (0.8)
Other	68 (9.6)	70 (9.8)
Not Reported	17 (2.4)	21 (2.9)
Patient ethnicity		
Hispanic or Latino	101 (14.3)	94 (13.2)
Not Hispanic or Latino	585 (83.0)	597 (83.8)
Not reported	19 (2.7)	21 (2.9)

* Race and ethnicity were reported by patients or their surrogates as part of clinical care and collected from the electronic health record by research personnel using fixed categories.
† Patients could have more than one.

Table S3. Active medical conditions at the time of intubation

Active Medical Condition*	Video Laryngoscope (n=705)	Direct Laryngoscope (n=712)
Neurologic – no. (%)		
Acute encephalopathy	463 (65.7)	458 (64.3)
Seizure or status epilepticus	81 (11.5)	78 (11.0)
Intracranial hemorrhage	65 (9.2)	67 (9.4)
Traumatic brain injury	32 (4.5)	30 (4.2)
Stroke	19 (2.7)	25 (3.5)
Meningitis or encephalitis	7 (1.0)	5 (0.7)
Spinal cord compression	2 (0.3)	4 (0.6)
Myasthenic crisis	6 (0.9)	1 (0.1)
Cardiac – no. (%)		
Cardiac arrest	48 (6.8)	65 (9.1)
Decompensated heart failure	16 (2.3)	19 (2.7)
Acute coronary syndrome	14 (2.0)	21 (2.9)
Cardiogenic shock	21 (3.0)	11 (1.5)
Hypertensive urgency or emergency	17 (2.4)	13 (1.8)
Pulmonary – no. (%)		
Hypoxemic respiratory failure	212 (30.1)	219 (30.8)
Hypercarbic respiratory failure	53 (7.5)	67 (9.4)
Pneumonia	61 (8.7)	70 (9.8)
COVID-19	41 (5.8)	41 (5.8)
Aspiration	21 (3.0)	31 (4.4)
Acute respiratory distress syndrome	17 (2.4)	30 (4.2)
Acute exacerbation of chronic obstructive pulmonary disease	15 (2.1)	20 (2.8)

Upper airway obstruction	8 (1.1)	5 (0.7)
Asthma exacerbation	7 (1.0)	4 (0.6)
Gastrointestinal – no. (%)		
Gastrointestinal bleeding	45 (6.4)	64 (9.0)
Acute liver failure	28 (4.0)	25 (3.5)
Bowel obstruction	6 (0.9)	8 (1.1)
Pancreatitis	6 (0.9)	7 (1.0)
Bowel perforation	5 (0.7)	2 (0.3)
Hepatorenal syndrome	2 (0.3)	3 (0.4)

*Abstracted from the electronic health record using prespecified categories. Patients could have more than one active condition.

Table S4. Chronic comorbidities

Comorbidity	Video Laryngoscope (n=705)	Direct Laryngoscope (m=712)
Respiratory conditions – no. (%)		
Chronic obstructive pulmonary disease	69 (9.8)	80 (11.2)
Asthma	46 (6.5)	42 (5.9)
Obstructive sleep apnea	26 (3.7)	27 (3.8)
Pulmonary hypertension	13 (1.8)	11 (1.5)
Pulmonary or pleural malignancy	8 (1.1)	11 (1.5)
Interstitial lung disease	10 (1.4)	8 (1.1)
Neuromuscular weakness	7 (1.0)	8 (1.1)
Recurrent aspiration	3 (0.4)	6 (0.8)
Cystic fibrosis	0 (0.0)	1 (0.1)
Other respiratory condition*	17 (2.4)	26 (3.7)
Non-respiratory conditions – no. (%)		
Hypertension	232 (32.9)	247 (34.7)
Diabetes mellitus	130 (18.4)	142 (19.9)
Hepatic cirrhosis	61 (8.7)	62 (8.7)
Congestive heart failure	58 (8.2)	65 (9.1)
Chronic kidney disease	63 (8.9)	55 (7.7)
Coronary artery disease	47 (6.7)	54 (7.6)
Atrial fibrillation	48 (6.8)	52 (7.3)
Solid malignancy, non-pulmonary	42 (6.0)	40 (5.6)
Hematologic malignancy	10 (1.4)	11 (1.5)
Cerebrovascular accident	32 (4.5)	33 (4.6)
End stage kidney disease	30 (4.3)	28 (3.9)
Traumatic brain injury	23 (3.3)	16 (2.2)

Solid organ transplant	12 (1.7)	13 (1.8)
Spinal cord injury	4 (0.6)	6 (0.8)
Other non-respiratory condition†	107 (15.2)	112 (15.7)

* Other respiratory conditions include pulmonary thromboembolic disease, lung transplantation, bronchiectasis not related to cystic fibrosis, and sequelae of prior fungal or mycobacterial pneumonia.
† Other non-respiratory conditions include abdominal aortic aneurysm, human immunodeficiency virus infection, hepatitis B virus infection, hepatitis C virus infection, dementia, epilepsy, and substance use disorder.

Table S5. Primary indication for tracheal intubation

Indication – no. (%)	Video Laryngoscope (n=705)	Direct Laryngoscope (n=712)
Encephalopathy	288 (40.9)	283 (39.7)
Hypoxemic respiratory failure	156 (22.1)	158 (22.2)
Hypercarbic and hypoxemic respiratory failure	33 (4.7)	26 (3.7)
Hypercarbic respiratory failure	22 (3.1)	29 (4.1)
Emergency procedure	41 (5.8)	51 (7.2)
Cardiac arrest	38 (5.4)	47 (6.6)
Agitation	30 (4.3)	41 (5.8)
Seizure	31 (4.4)	30 (4.2)
Upper airway obstruction	23 (3.3)	18 (2.5)
Hemodynamic instability	24 (3.4)	19 (2.7)
Hemoptysis	5 (0.7)	1 (0.1)
Metabolic acidosis	4 (0.6)	3 (0.4)
Respiratory arrest	4 (0.6)	3 (0.4)
Other	6 (0.9)	3 (0.4)

Table S6. Management before induction

Measure	Video Laryngoscope (n=705)	Direct Laryngoscope (n=712)
Glasgow Coma Scale score – median (IQR)	10 (5-14)	10 (6-14)
Vasopressor in hour prior – no. (%)*	115 (16.3)	133 (18.7)
Norepinephrine	85 (12.1)	101 (14.2)
Epinephrine	22 (3.1)	24 (3.4)
Vasopressin	21 (3.0)	24 (3.4)
Phenylephrine	15 (2.1)	9 (1.3)
Dopamine	1 (0.1)	0 (0.0)
Dobutamine	1 (0.1)	3 (0.4)
Milrinone	1 (0.1)	0 (0.0)
Noninvasive ventilation for respiratory failure in the hour prior to induction – no. (%)	85 (12.1)	89 (12.5)
HFNC for respiratory failure in the hour prior to induction – no. (%)	60 (8.5)	54 (7.6)
Highest FIO2 in the hour prior to induction	0.30 (0.21-0.66)	0.32 (0.21-0.66)
Lowest oxygen saturation in the hour prior to induction – (%)	95 (90-98)	95 (91-98)
Blade geometry the operator planned to use if patient was randomized to video laryngoscope group – no. (%)		
Standard (Macintosh)	538 (76.3)	542 (76.1)
Hyperangulated	89 (12.6)	84 (11.8)
Not reported	78 (11.1)	86 (12.1)
Preoxygenation – no. (%)*		
None	3 (0.4)	1 (0.1)
Standard nasal cannula	126 (17.9)	131 (18.4)

High-flow nasal cannula	38 (5.4)	50 (7.0)
Nonrebreather mask	359 (50.9)	344 (48.3)
Bag-mask device (no ventilation provided)	54 (7.7)	52 (7.3)
Bag-mask device (ventilation provided)	111 (15.7)	112 (15.7)
Supraglottic airway device	29 (4.1)	35 (4.9)
Non-invasive ventilation via dedicated machine	120 (17.0)	136 (19.1)
Non-invasive ventilation via invasive mechanical ventilator	28 (4.0)	25 (3.5)
Duration of preoxygenation – no. (%), minutes		
< 1 minute	14/702 (2.0)	13/709 (1.8)
1-2.9 minutes	71/702 (10.1)	72/709 (10.2)
3-5 minutes	199/702 (28.3)	210/709 (29.6)
> 5 minutes	418/702 (59.5)	414/709 (58.4)
Lowest oxygen saturation during preoxygenation – no. (%)		
< 85%	65 (9.2)	64 (9.0)
85-90%	56 (7.9)	55 (7.7)
91-95%	99 (14.0)	103 (14.5)
> 95%	438 (62.1)	454 (63.8)
Not available	47 (6.7)	36 (5.1)

* Patients could receive more than one.

Table S7. Additional Operator Characteristics

Characteristic	Video Laryngoscope (n=705)	Direct Laryngoscope (n=712)
No. of unique operators*	284	288
No. of enrollments per operator*		
Median (IQR)	1 (1-3)	1 (1-3)
Range	1-19	1-24

*A total of 387 unique operators performed an intubation in the trial, with each operator contributing a median of 2 (IQR, 1 to 4) intubations.

Table S8. Description of patients who did not receive the assigned laryngoscope on the first attempt

Patient	Laryngo-scope assigned	Laryngo-scope received	Reason for not using the assigned laryngoscope	Successful intubation on the first attempt
Patient 1	DL	VL	Change in patient condition (severe hypoxemia after induction)	Yes
Patient 2	DL	VL	Change in patient condition (severe hypoxemia after induction)	Yes
Patient 3	DL	VL	Change in patient condition (cardiac arrest after induction)	No
Patient 4	DL	VL	Anticipated difficulty related to upper airway anatomy	No
Patient 5	DL	VL	Change in patient condition (cardiac arrest after enrollment, before induction)	Yes
Patient 6	DL	VL	Change in planned operator post-randomization. New operator preferred VL given anticipated difficulty	Yes
Patient 7	DL	VL	Anticipated difficulty due to cervical spine injury	Yes
Patient 8	DL	VL	Change in patient condition (severe hypotension after induction)	No

DL, direct laryngoscope; VL, video laryngoscope.

Table S9. Management from induction to laryngoscopy

Measure	Video Laryngoscope (n=705)	Direct Laryngoscope (n=712)
Sedative medication for induction*		
Etomidate – no. (%)	586 (83.1)	582 (81.7)
Median dose (IQR), mg	20 (20-20)	20 (20-20)
Ketamine – no. (%)	65 (9.2)	73 (10.3)
Median dose (IQR), mg	120 (100-153)	100 (90-150)
Propofol – no. (%)	28 (4.0)	26 (3.7)
Median dose (IQR), mg	45 (30-100)	55 (50-100)
Midazolam – no. (%)	20 (2.8)	22 (3.1)
Median dose (IQR), mg	4 (2-4)	3 (2-4)
Fentanyl – no. (%)	19 (2.7)	16 (2.2)
Median dose (IQR), micrograms	75 (50-100)	50 (50-100)
Lorazepam – no. (%)	2 (0.3)	0 (0.0)
Median dose (IQR), mg†	--	--
None	27 (3.8)	29 (4.1)
Not reported	10 (1.4)	7 (1.0)
Neuromuscular blocking agent‡		
Succinylcholine – no. (%)	172 (24.4)	169 (23.7)
Median dose (IQR), mg	145 (100-200)	140 (100-200)
Rocuronium – no. (%)	497 (70.5)	512 (71.9)
Median dose (IQR), mg	100 (80-100)	100 (85-100)
None – no. (%)	28 (4.0)	29 (4.1)
Not reported – no. (%)	9 (1.3)	6 (0.8)
Oxygenation and ventilation between induction and laryngoscopy – no. (%)*		

None	39 (5.5)	34 (4.8)
Nasal cannula	102 (14.5)	111 (15.6)
High flow nasal cannula	18 (2.6)	25 (3.5)
Non-rebreather mask	184 (26.1)	166 (23.3)
Supraglottic airway device	20 (2.8)	25 (3.5)
Bag-mask device (no ventilation provided)	50 (7.1)	47 (6.6)
Bag-mask device (ventilation provided)	252 (35.7)	265 (37.2)
Non-invasive ventilation via dedicated machine	95 (13.5)	111 (15.6)
Non-invasive ventilation via invasive mechanical ventilator	27 (3.8)	21 (2.9)
Time interval between induction and laryngoscopy, seconds		
Median (IQR)	63 (47-85)	65 (48-86)
Mean (standard deviation)	72 (45)	76 (56)
Time interval between laryngoscopy and successful intubation, seconds		
Median (IQR)	38 (26-60)	46 (30-83)
Mean (standard deviation)	59 (90)	78 (95)
Time interval between induction and successful intubation, seconds		
Median (IQR)	108 (84-141)	120 (88-176)
Mean (standard deviation)	132 (104)	152 (115)

* Patients could receive more than one.
† The median (IQR) dose for lorazepam could not be calculated due to only 2 patients receiving this medication. Their doses were 1 and 2 mg, respectively.
‡ A total of 5 patients (0.4%) received both succinylcholine and rocuronium during intubation: 1 in the video laryngoscope group and 4 in the direct laryngoscope group.

Table S10. Management of laryngoscopy and intubation

Measure	Video Laryngoscope (n=705)	Direct Laryngoscope (n=712)
View of the larynx obtained using the video screen on the first attempt – no. (%)	674/690 (97.7)	8 (1.1)
Size of laryngoscope blade – no. (%)		
Size 3	174/630 (27.6)	196/678 (28.9)
Size 4	456/630 (72.4)	482/678 (71.1)
Size of the endotracheal tube, mm – median (IQR)		
5.0	0/698 (0.0)	1/703 (0.1)
5.5	0/698 (0.0)	0/703 (0.0)
6.0	0/698 (0.0)	0/703 (0.0)
6.5	2/698 (0.3)	3/703 (0.4)
7.0	45/698 (6.4)	77/703 (11.0)
7.5	531/698 (76.1)	497/703 (70.7)
8.0	120/698 (17.2)	125/703 (17.8)

Table S11. Patient characteristics reported by the operator after intubation or in the medical record that may affect the difficulty of laryngoscopy and intubation

Characteristic*	Video Laryngoscope (n=705)	Direct Laryngoscope (n=712)	Absolute Difference or Median Difference (95% CI)
Limited mouth opening†‡	84 (11.9)	98 (13.8)	-1.8 (-5.5 to 1.8)
Large tongue†	75 (10.6)	81 (11.4)	-0.7 (-4.1 to 2.7)
Small mandible†	26 (3.7)	44 (6.2)	-2.5 (-4.9 to -0.1)
Short neck†	84 (11.9)	81 (11.4)	0.5 (-2.9 to 4.0)
Large neck circumference†	81 (11.5)	103 (14.5)	-3.0 (-6.6 to 0.7)
Limited neck mobility†‡	67 (9.5)	112 (15.7)	-6.2 (-9.8 to -2.6)
Cervical collar before intubation†	72 (10.2)	83 (11.7)	-1.4 (-4.8 to 1.9)
Prior head and neck radiation‡	5 (0.7)	4 (0.6)	0.1 (-0.8 to 1.1)
Upper airway mass, infection, or trauma‡	9 (1.3)	9 (1.3)	0.0 (-1.2 to 1.2)
Epistaxis or oral bleeding‡	12 (1.7)	13 (1.8)	-0.1 (-1.6 to 1.4)
Upper gastrointestinal bleeding complicating intubation‡	8 (1.1)	7 (1.0)	0.2 (-1.1 to 1.4)
Active vomiting‡	22 (3.1)	26 (3.7)	-0.5 (-2.6 to 1.5)
Witnessed aspiration‡	2 (0.3)	9 (1.3)	-1.0 (-2.0 to 0.1)
Body fluids obscuring the view of the vocal cords†	120 (17.0)	132 (18.5)	-1.5 (-5.6 to 2.6)
Airway edema†	20 (2.8)	24 (3.4)	-0.5 (-2.5 to 1.4)

* Patients could have more than one. These characteristics were reported or recorded after the tracheal intubation procedure. Trial group assignment and the trial interventions may have influenced the reporting of these characteristics. These characteristics were not considered to be baseline characteristics and were not used in any analyses. The characteristics are presented here to describe the patient population and facilitate comparison to the patient populations of other studies. Confidence intervals were not adjusted for multiple comparisons, so they should not be used for hypothesis testing.
† Reported by the operator immediately after completion of the intubation procedure.
‡ Collected by study personnel from the electronic health record.

Table S12. Multivariable model for the primary outcome of successful intubation on the first attempt

Variable	Odds Ratio	95% Confidence Interval
Video laryngoscope group : Direct laryngoscope group	2.55	1.94 to 3.30

This table shows the results of the multivariable model. We fit a generalized linear mixed effects model using a logit link function with the primary outcome as the dependent variable, study site as a random effect, and fixed effects of study group and the following variables: age in years, female sex, body mass index (kg/m^2), the operator's prior experience (total number of prior intubations), and ICU location of intubation. Age, body-mass index, and the operator's total number of prior intubations were modeled with a nonlinear relationship to the outcome using restricted cubic splines with between 3 and 5 knots. An odds ratio greater than 1.0 indicates a greater odds of successful intubation on the first attempt.

Table S13. Sensitivity analyses of the primary outcome

Analysis	Sample Size	VL group	DL group	Absolute Difference (95% CI)	P value
		No. with first attempt success / total no. in analysis (%)			
Prespecified Analyses					
Primary Analysis	1,417	600/705 (85.1)	504/712 (70.8)	14.3 (9.9 to 18.7)	0.00000000008
Repeating the primary analysis but considering crossover from the assigned laryngoscope to the non-assigned laryngoscope to represent unsuccessful intubation on the first attempt.	1,417	600/705 (85.1)	499/712 (70.1)	15.0 (10.6 to 19.4)	0.00000000001
Repeating the primary analysis but including only the subgroup of patients for whom data on the primary outcome was available from the independent observer, excluding 8 patients for whom data on the primary outcome from independent observer were unavailable and the operator's self-report was used to determine whether successful intubation on the first attempt had occurred.	1,409	599/704 (85.1)	499/705 (70.8)	14.3 (9.9 to 18.7)	0.0000000001
Repeating the primary analysis but including only patients for whom the operator's proportion of prior intubations performed using a video laryngoscope was between 0.25 and 0.75.	827	335/398 (84.2)	303/429 (70.6)	13.5 (7.7 to 19.4)	0.000004
***Post hoc* Analyses**					
Repeating the primary analysis including only patients enrolled at sites where an attending physician is always present for every intubation.	1,209	518/605 (85.6)	430/604 (71.2)	14.4 (9.7 to 19.2)	--

Repeating the primary analysis including only patients enrolled at sites where an attending physician is NOT always present for every intubation.	208	82/100 (82.0)	74/108 (68.5)	13.5 (1.0 to 26.0)	--
Repeating the primary analysis including only patients for whom operators recorded prior to randomization that they would use a standard geometry blade if randomized to the video laryngoscope group.	1080	464/538 (86.2)	391/542 (72.1)	14.1 (9.2 to 19.1)	--
Repeating the primary analysis including only patients for whom operators recorded prior to randomization that they would use a hyperangulated blade if randomized to the video laryngoscope group.	173	71/89 (79.8)	54/84 (64.3)	15.5 (1.1 to 29.9)	--
Repeating the primary analysis including only patients with blood or body fluid obscuring the view of the vocal cords.	252	90/120 (75.0)	79/132 (59.8)	15.2 (3.0 to 27.3)	--
Generalized linear mixed effects model with the primary outcome as the dependent variable, operator and study site as random effects, and fixed effects of study group and the following variables: age in years, female sex, body mass index (kg/m^2), the operator's prior experience (total number of prior intubations), and ICU location of intubation.	1417	600/705 (85.1)	504/712 (70.8)	16.3 (11.2 to 21.5)	--

Table S14. Relationship between successful intubation on the first attempt and severe complications of intubation.

Outcome*	Overall	Video Laryngoscope	Direct Laryngoscope
Severe complication during intubation	300/1417 (21.2)	151/705 (21.4)	149/712 (20.9)
Successful intubation on first attempt	200/1104 (18.1)	116/600 (19.3)	84/504 (16.7)
Failure to intubate on the first attempt	100/313 (31.9)	35/105 (33.3)	65/208 (31.3)
SpO_2 < 80%	133/1317 (10.1)	64/658 (9.7)	69/659 (10.5)
Successful intubation on first attempt	69/1026 (6.7)	41/560 (7.3)	28/466 (6.0)
Failure to intubate on the first attempt	64/291 (22.0)	23/98 (23.5)	41/193 (21.2)
Systolic blood pressure < 65 mm Hg	49/1268 (3.9)	20/624 (3.2)	29/644 (4.5)
Successful intubation on first attempt	29/987 (2.9)	11/529 (2.1)	18/458 (3.9)
Failure to intubate on the first attempt	20/281 (7.1)	9/95 (9.3)	11/186 (5.9)
New or increased vasopressors	178/1417 (12.6)	91/705 (12.9)	87/712 (12.2)
Successful intubation on first attempt	137/1104 (12.4)	76/600 (12.7)	61/504 (12.1)
Failure to intubate on the first attempt	41/313 (13.1)	15/105 (14.3)	26/208 (12.5)
Cardiac arrest not resulting in death	2/1417 (0.1)	2/705 (0.3)	0/712 (0.0)
Successful intubation on first attempt	1/1104 (0.1)	1/600 (0.2)	0/504 (0.0)
Failure to intubate on the first attempt	1/313 (0.3)	1/105 (1.0)	0/208 (0.0)
Cardiac arrest resulting in death	4/1417 (0.3)	1/705 (0.1)	3/712 (0.4)
Successful intubation on first attempt	2/1104 (0.2)	0/600 (0.0)	2/504 (0.4)
Failure to intubate on the first attempt	2/313 (0.6)	1/105 (1.0)	1/208 (0.5)

* Patients could have more than one severe complication. Analyses shown here were *post hoc*.

Table S15. Reason for failure on the first intubation attempt

Reason – no. (%)*	Video Laryngoscope (n=705)	Direct Laryngoscope (n=712)	Absolute Difference or Median Difference (95% CI)
Inadequate view of the vocal cords	26 (3.7)	123 (17.3)	-13.6 (-16.8 to -10.3)
Inability to pass the endotracheal tube	44 (6.2)	32 (4.5)	1.7 (-0.7 to 4.2)
Inability to pass the bougie	7 (1.0)	19 (2.7)	-1.7 (-3.2 to -0.1)
Attempt aborted due to patient condition	2 (0.3)	14 (2.0)	-1.7 (-2.9 to -0.4)
Technical failure of the laryngoscope	2 (0.3)	4 (0.6)	-0.3 (-1.1 to 0.5)
Other	13 (1.8)	10 (1.4)	0.4 (-1.0 to 1.9)
Not reported	23 (3.3)	40 (5.6)	-2.4 (-4.6 to -0.1)

***** Reasons for failure were reported by the operator. Patients could have more than one. Confidence intervals were not adjusted for multiple comparisons, so they should not be used for hypothesis testing.

Table S16. Additional procedural outcomes

Characteristic*	Video Laryngoscope (n=705)	Direct Laryngoscope (n=712)	Absolute Difference (95% CI)
No. of total laryngoscope insertions† – no. (%)			
1 insertion	636/704 (90.3)	546/706 (77.3)	13.0 (9.1 to 16.9)
2 insertions	54/704 (7.7)	127/706 (18.0)	-10.3 (-13.9 to -6.7)
≥ 3 insertions	14/704 (2.0)	33/706 (4.7)	-2.7 (-4.7 to -0.7)
No. of total bougie insertions† – no. (%)			
0 insertions	364/705 (51.6)	330/707 (46.7)	5.0 (-0.4 to 10.3)
1 insertion	316/705 (44.8)	317/707 (44.8)	0.0 (-5.2 to 5.2)
2 insertions	19/705 (2.7)	33/707 (4.7)	-2.0 (-4.1 to 0.1)
≥ 3 insertions	6/705 (0.9)	27/707 (3.8)	-3.0 (-4.7 to -1.3)
No. of total endotracheal tube insertions† – no. (%)			
1 insertion	646/704 (91.8)	620/705 (87.9)	3.8 (0.5 to 7.1)
2 insertions	43/704 (6.1)	66/705 (9.4)	-3.3 (-6.2 to -0.3)
≥ 3 insertions	15/704 (2.1)	19/705 (2.7)	-0.6 (-2.3 to 1.2)
Components of the secondary outcome			
Lowest oxygen saturation, % – median (IQR)	98 (91-100)	98 (91-100)	0 (-1 to 1)
Lowest systolic blood pressure, mmHg – median (IQR)	120.5 (102-143)	121 (100-145)	-0.5 (-4.0 to 5.5)
Other complications			
Injury to airway structures – no. (%)	2 (0.3)	0 (0.0)	0.3 (-0.3 to 0.8)

* Confidence intervals were not adjusted for multiple comparisons, so they should not be used for hypothesis testing.
† These data on the number of laryngoscope insertions, bougie insertions, and endotracheal tube insertions were reported by an independent observer and do not include data reported by the operator. Data from the independent observer regarding laryngoscope insertions were

missing for 7 patients, regarding bougie insertions were missing for 5 patients, and for endotracheal tube insertions were missing for 8 patients.

Table S17. Management on the final intubation attempt when successful intubation on the first attempt did not occur

Measure*	Video Laryngoscope	Direct Laryngoscope	Absolute Difference or Median Difference (95% CI)
Among all patients	**(n=705)**	**(n=712)**	
Successful intubation on the first attempt (no additional attempts required) – no. (%)	600 (85.1)	504 (70.8)	14.3 (9.9 to 18.7)
Approach used on the final intubation attempt when successful intubation on the first attempt did not occur – no. (%)			
Video laryngoscope	65 (9.2)	123 (17.3)	-8.1 (-11.7 to -4.4)
Direct laryngoscope	3 (0.4)	39 (5.5)	-5.1 (-6.9 to -3.2)
Flexible endoscope	1 (0.1)	0 (0.0)	0.1 (-0.3 to 0.6)
Cricothyrotomy	0 (0.0)	1 (0.1)	-0.1 (-0.6 to 0.3)
Not reported	36 (5.1)	45 (6.3)	-1.2 (-3.8 to 1.3)
Operator different than first attempt	19 (2.7)	24 (3.4)	-0.7 (-2.6 to 1.3)
Among only patients who did not experience successful intubation on the first attempt	**(n=105)**	**(n=208)**	
Video laryngoscope	65 (61.9)	123 (59.1)	2.8 (-9.4 to 14.9)
Direct laryngoscope	3 (2.9)	39 (18.8)	-15.9 (-22.8 to -9.0)
Flexible endoscope	1 (1.0)	0 (0.0)	1.0 (-1.6 to 3.5)
Cricothyrotomy	0 (0.0)	1 (0.5)	-0.5 (-1.9 to 0.9)
Not reported	36 (34.3)	45 (21.6)	12.7 (1.3 to 24.0)
Operator different than first attempt	19 (18.1)	24 (11.5)	6.6 (-2.7 to 15.8)

***** Confidence intervals were not adjusted for multiple comparisons, so they should not be used for hypothesis testing.

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